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Marsh, G.M. (2002) "Health risks from exposure to Zonolite home insulation: critical evaluation of the scientific evidence available from the ATSDR studies in Libby, Montana," report prepared for W.R. Grace.

McDonald, J.C., McDonald, A.D., Armstrong, B. and Sebastien, P. (1986) "Cohort study of mortality of vermiculite miners exposed to tremolite," *British Journal of Industrial Medicine*, **43**, 436-444.

NCP, the National Contingency Plan (NCP, 40 Code of Federal Regulations 300.430(e)(2)(i)(A)(2)).

NRC (1983) "Risk Assessment in the Federal Government: Managing the Process," National Research Council on the Institutional Means for Assessment of Risks to Public Health, Commission on Life Sciences, National Academy Press, Washington, DC., 1983.

NRDC v. EPA (1987) *Natural Resources Defense Council, Inc. v. U.S.E.P.A.*, 824 F.2d 1146 (D.C. Cir. 1987).

Oehlert, G.W., Lee, R.J., Van Orden, D. (1995) "Statistical Analysis of Asbestos Fibre Counts," *Environmetrics*, **6**, 155-126.

Pinchin Environmental (1997) "Site Assessment Vermiculite Removal Building E-12 C.F.B. Shilo, Shilo, Manitoba, Final Report," prepared for the Department of National Defence, Shilo, Manitoba, April 1997.

U.S. Department of Commerce, *Statistical Abstract of the United States - 1996*, Bureau of the Census, October 1996.

U.S. Department of Labor: OSHA Regulations. 29 CFR 1910.1001- *General Industry Asbestos Standard* and 29 CFR 1926.58- *Construction Industry Asbestos Standard*. June 1986; Amended August 1994.

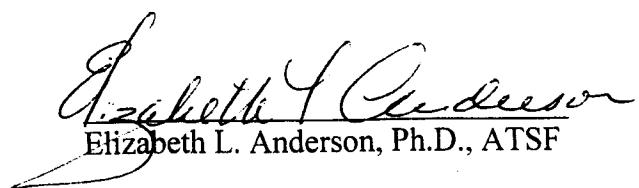
Versar (1982) "Exposure Assessment for Asbestos-Contaminated Vermiculite, Interim Final Report," prepared for the U.S. Environmental Protection Agency.

Versar (2002) "Asbestos Exposure Assessment for Vermiculite Attic Insulation; Cumulative Study Covering Research Conducted in 2001 and 2002, Preliminary Draft," report prepared for the U.S. Environmental Protection Agency.

Weis, C.P. (2001) "Amphibole Mineral Fibers in Source Materials in Residential and Commercial Areas of Libby Pose an Imminent and Substantial Endangerment to Public Health," memorandum from Christopher P. Weis to Paul Peronard, U.S. Environmental Protection Agency Region VIII, December 20, 2001.

The foregoing represents my opinion to a reasonable degree of scientific certainty.

Date: April 14, 2003


Elizabeth L. Anderson, Ph.D., ATSF

Appendix A

Curricula Vitae for Dr. Elizabeth Anderson

ELIZABETH L. ANDERSON

EDUCATION

1970 Ph.D., Fellow, A.T.S., Organic Chemistry, The American University

1964 M.S., Organic Chemistry, University of Virginia

1962 B.S., Chemistry, College of William and Mary

EXPERIENCE

Elizabeth L. Anderson, Ph.D., Fellow, ATS, is President and Chief Executive Officer of Sciences International, Inc. and has over 20 years experience, both government and corporate, in health and the environmental sciences. Formerly she was President, Chief Executive Officer, and Chairman of the Board of Clement International Corporation (ICFI), where she directed an interdisciplinary group of 200 senior scientists and engineers. At the U.S. Environmental Protection Agency (EPA), she established and directed the central risk assessment program for 10 years. Specifically, in 1976, Dr. Anderson established the Carcinogen Assessment Group (CAG) which formed the core for the later Office of Health and Environmental Assessment, which she also directed, with a staff of over 140 and a budget of more than \$14 million. The primary functions of the office were to conduct risk assessments on the health effects of a wide variety of toxic chemicals, provide leadership to establish EPA-wide guidelines for risk assessment, and oversee EPA's risk assessment program. Dr. Anderson is an internationally recognized lecturer and consultant and has published numerous journal articles in the areas of risk assessment and carcinogenicity. She is the recipient of the EPA Gold Medal for Exceptional Service.

Establishes and Directs Major Health and the Environmental Science Programs

- **President & CEO, Sciences International, Inc.** At Sciences International, directs an interdisciplinary staff of senior scientists involved in the evaluation of a wide range of health and environmental issues. Projects include the production of health criteria documents; the risk assessment of hazardous waste sites, air emissions sources, and pesticide uses; the evaluation of environmental assessments related to new drug registration; exposure assessment; environmental transport and fate issues; large scale epidemiology evaluations involving the impact of pollution on human health; and the development of ecological risk assessment methods and protocols. The risk assessments are multimedia and involve the development of novel methods and approaches for evaluating human health and ecological risk.
- **President & CEO, Clement International Corp.** At Clement International Corporation oversaw large-scale programs providing technical support in the health and environmental sciences including the K.S. Crump Division and the Systems Applications Division, which joined Clement in 1986 and 1990, respectively. Projects include International (SAI) development of biologically based models to improve health risk assessment, laboratory audits, and related product registrations; development of risk assessment methods; conduct of risk

assessments to evaluate health risks associated with toxic chemical exposures including waste site cleanup, waste disposal, incineration processes, worker and community health issues, and air, soil, surface, and groundwater contamination.

Pioneer in Formulation of National Risk Assessment Policy

- **Established the EPA Carcinogen Assessment Group.** Established Carcinogen Assessment Group (CAG), a group of senior scientists with liaison members from other federal agencies and the private sector, and oversaw its growth from a staff of 2 to more than 20. The CAG was responsible for EPA's carcinogen risk assessment activities. Assembled and supervised interdisciplinary scientific staff; responsible for administration of office and scientific product of group.
- **Director, EPA's Risk Assessment Program.** Was responsible for EPA's risk assessment program. Directed an interdisciplinary group of senior scientists responsible for the development of EPA's adoption of risk assessment and risk management as a policy. Directed the first health assessment guidelines effort; reviewed agency risk assessments to ensure consistency and technical competence. The office also evaluated health data and wrote criteria and health assessment documents used in the establishment of water quality criteria and drinking water standards; the regulation of air pollutants, radioactive materials, and toxic chemicals; the registration of pesticides; the approval of permits for waste disposal; the establishment of reportable quantities for emergency spills; and the cleanup of hazardous waste sites.
- Chaired interagency work groups to develop federal guidelines for risk assessment.

Internationally Recognized Consultant, Author, and Speaker on Health and Environmental Issues

- Consultant for a variety of international organizations, such as the World Health Organization and the Pan American Health Organization, and for individual countries. Advised them on risk assessment methods and guidelines for public health evaluations of the risks posed by exposure to toxic chemicals. Assessed the risks associated with economic development and conducted collaborative health studies that provided a basis for risk assessments.
- Lectured and published widely on risk assessment methods and the use of risk assessment in the management of toxic chemicals.

HONORS

Twentieth Century Distinguished Service Award, Ninth Lukacs Symposium, 1999

Outstanding Service Award, Society for Risk Analysis, 1997

Jerry F. Stara Memorial Award, 1994

SES Bonus for Outstanding Performance, 1984

EPA Gold Medal for Exceptional Service, 1978

Kappa Kappa Gamma National Achievement Award, 1974

PROFESSIONAL AFFILIATIONS

American Association for the Advancement of Science
American College of Toxicology
New York Academy of Sciences
Society for Risk Analysis
Cosmos Club
Society of Toxicology

PROFESSIONAL CERTIFICATION

1999 Fellow, Academy of Toxicological Sciences

PROFESSIONAL ACTIVITIES

Peer review committee, "Assessment & recommendations for the South Carolina air toxics standard." July 2000.

Peer review committee, EPA's EMPACT Metro Area Grants Program, July 1999, 2000.

Appointed to Cardinal Bank Board of Directors. 3-year appointment effective July 1999.

Member of External Evaluation Group, Los Alamos National Laboratory, March 1999 - 2004.

Appointed by National Research Council (NRC) and the Commission on Life Sciences, Board on Environmental Studies and Toxicology, as member of the NRC Committee on Assessment of Risks from Remediation of PCB-Contaminated Sediments, 1999 - 2001.

Chair, peer review of the Office of Risk Assessment and Cost Benefit Analysis, U.S. Department of Agriculture, January 1999.

Editor-in Chief, Risk Analysis: An International Journal. 5-year appointment effective January 1999 -2004.

Peer review committee, Environmental Monitoring for Public Access and Community Tracking (EMPACT), National Center for Environmental Research and Quality Assurance, U.S. Environmental Protection Agency, 1999.

Blue Ribbon Advisory Board, Steering Committee, Florida Atlantic University Environmental Business Management Program, 1998.

Executive Advisory Board of Directors, University of Virginia, School of Engineering and Applied Sciences, Northern Virginia Graduate Degree Program in Systems Engineering, 1998 - 2003.

George Mason University Women's Advisory Board, 1998 - 2001.

Senior Biomedical Research Service (SBRS) Credentials Committee, Food and Drug Administration, 1998.

Chair, External Review Committee, United States Department of Agriculture, Office of Risk Assessment and Cost-Benefit Analysis. Selected by the Society for Risk Analysis, 1998.

External Review Committee, Los Alamos National Laboratory, Department of Energy, 1998.

Board of Scientific Counselors, Committee to Review the National Health and Environmental Effects Research Laboratory, U.S. Environmental Protection Agency. 1998.

Peer review committee, Exploratory Research Program, Environmental Chemistry, U.S. Environmental Protection Agency, 1997 and 1998.

Peer review committee, Exploratory Research Program, Environmental Physics, U.S. Environmental Protection Agency, 1997.

Department of Defense peer review committee, Strategic Environmental Research and Development Program (SERDP), 1997.

Chair, peer review committee, Risk assessment guidelines for combustion sources, U.S. Environmental Protection Agency, 1996.

Peer review committee, Center for Risk Assessment, U.S. Environmental Protection Agency, 1996.

Dean's advisory council for the School of Engineering and Applied Science at the University of Virginia, 1996-present.

Board of Trustees, Wildfowl Trust of America, appointed 1994-1997.

External advisory board, Center for Risk Management of Engineering Systems, University of Virginia, 1987 - present.

Editorial board for the journal Human and Ecological Risk Assessment; appointed 1994 - present.

Advisory board of the Wildfowl Trust of North America, appointed 1993.

New York Power Commission advisory panel to recommend research programs to evaluate risk associated with electric and magnetic fields, 1990

Risk assessment review panel for the State of New Jersey, appointed 1988

Member of panel of experts evaluating risk analysis activities of four federal agencies, Program Evaluation and Methodology Division, General Accounting Office, for House Committee on Science and Technology, February 1986

Charter member, Society for Risk Analysis (member of steering committee to establish society, 1980); member of editorial board, Risk Analysis; elected council member, 1981; president, 1984-1985; chair, conferences and workshops committee, 1996-1998.

Member, subcommittee on risk analysis, health and environmental research advisory committee, Department of Energy, 1985

EPA representative to the National Cancer Advisory Board, 1982-1985

Member, interagency risk management council, cabinet council committee; chairman, committee to develop guidelines for assessing reproductive risk

Member, principles for evaluating health risks to progeny associated with exposure to chemicals during pregnancy, International Program for Chemical Safety (IPCS) committee editorial staff, World Health Organization, Geneva, Switzerland, 1984

Member, interagency regulatory liaison group, work group on risk assessment (work group published the article, scientific bases for identification of potential carcinogens and estimation of risks, JNCI 63:242, 1979); chairman of the work group, 1980

Member, risk analysis liaison committee, National Academy of Sciences/National Science Foundation (under P.L. 96-44)

Member, National Academy of Sciences/Food and Drug Administration advisory committee on institutional means for assessment of risk to public health (under H.R. 7591)

PATENT

Anderson, E.L., Brown, E. Thickness-Scratch Testing Device. No. 3,738,011. Granted June 1973.

PUBLICATIONS

Subramaniam RP, Turim J, Golden SL, Kral P, and Anderson EL. 2001. An Exploratory Study of Variations in Exposure to ETS in the United States. Risk Analysis. Vol. 21, No. 3, pp 561-574.

Anderson, E.L., Goldman, S., Kral, P., Subramaniam, R., Turim, J. 1999. Risk Assessment of Indoor Air Pollutants. In: Proceedings from The Fourth Princess Chulabhorn International Science Congress: Chemicals in the 21st Century. The Chulabhorn Research Institute. November 28 - December 2, 1999. Bangkok, Thailand.

Hattis, D., Anderson, E.L. 1999. What Should be the Implications of Uncertainty, Variability, and Inherent 'Biases'/'Conservatism' for Risk Management Decision-Making? Risk Analysis. Vol. 19, No. 1. February.

Moolgavkar, S.H., Luebeck, E.G., Anderson, E.L. 1998. Estimation of Unit Risk for Coke Oven Emissions. Risk Analysis. Vol. 18, No. 6.

Anderson, E.L., Albert, R.E. 1998. Risk assessment and indoor air quality. Monograph. A volume in the Indoor Air Research Series. CRC Lewis Publishers.

Moolgavkar, S.H., Luebeck, E.G., Anderson, E.L. 1997. Air pollution and hospital admissions for respiratory causes in Minneapolis-St. Paul and Birmingham. Epidemiology 8(4)364-370.

Moolgavkar, S.H., Luebeck, E.G., Hall, T.A., Anderson, E.L. 1995. Air pollution and daily mortality in Philadelphia. Epidemiology 6(5)476-484.

Moolgavkar, S.H., Luebeck, E.G., Hall, T.A., Anderson, E.L. 1994. Particulate air pollution, sulfur and daily mortality: A reanalysis of the Steubenville data. Colloquium on particulate air pollution and human mortality and morbidity, Irvine, California. *Journal of Inhalation Toxicology*, Vol. 7(1995) pp 35-44.

Anderson, E., Deisler, P.F., McCallum, D., St. Hilaire, C., Spitzer, H., Strauss, H., Wilson, J.D., Zimmerman, R. 1993. Key issues in carcinogen risk assessment guidelines. *Risk Analysis*, Vol. 14, No. 4.

Chrostowski, P.C., Hartley, S., Foster, S.A., Anderson, E.L. 1991. Human health risks associated with asbestos abatement. *Risk Analysis*, Vol. 11, No. 3.

Voytek, P., Anver, M., Thorslund, T., Conley, J., Anderson, E.L. 1990. Mechanisms of asbestos carcinogenicity. *J. of the American College of Toxicology*, Vol. 9, No. 5.

Anderson, E.L., Chrostowski, P.C., Vreeland, J.L. 1990. "Risk assessment issues associated with cleaning up inactive hazardous waste sites." In *Integrating Insurance and Risk Management for Hazardous Wastes*. Kunreuther, H., Gouda, M.U.R., eds. Boston: Kluner Academic Publishers

Anderson, E.L., Chrostowski, P.C., Vreeland, J. 1990. Risk assessment for use in groundwater management. *Risk Assessment for Groundwater Pollution Control*, American Society of Civil Engineers.

Voytek, P., Anver, M., Thorslund, T., Conley, J., Anderson, E.L. 1990. Mechanisms of asbestos carcinogenicity. *Journal of the American College of Toxicology* 9(5)541-550.

Anderson, E.L. 1989. Scientific developments in risk assessment: Legal implications. *Columbia Journal of Environmental Law*, Vol. 14, No. 2.

Anderson, E.L., Chrostowski, P.C., Foster, S. 1988. Calculating the Risks. *Solid Waste & Power* 2(3)40-47.

Anderson, E.L., Henry, C.J. 1988. Risk assessment/risk management as a toxic control strategy. World conference on large lakes, Mackinac Island, Michigan. In *Toxic contamination in large lakes*. Vol III. Sources, fate, and controls of toxic contaminants. Schmidtke, N.W., ed. Lewis Publishers.

Anderson, E.L. 1988. The risk analysis process. *Contemporary Issues in Risk Analysis*. Volume 3. *Carcinogen Risk Assessment*. Travis, C.C., ed. Plenum Press, pp. 3-17.

Anderson, E.L. 1988. Perspective on risk assessment of carcinogens. *Banbury Report 31: Carcinogen Risk Assessment: New directions in the Qualitative and Quantitative Aspects*. Cold Spring Harbor Laboratory, pp. 281-294.

Bridgen, P.J., Anderson, E.L. October, 1986. Processes and parameters involved in risk assessment for environmental release of biotechnology products. Annual meeting of the Society for Risk Analysis, Washington, DC.

Anderson, E.L., Albert, R.E., Kamey, D. 1986. Risk assessments/risk management for environmental uses of biological agents. Invited paper for Banbury Conference on Genetically

Altered Viruses and the Environment. Cold Spring Harbor Laboratory, April 28-May 1, 1985. Published in Banbury Report No. 22, p. 33.

Anderson, E.L. 1985. Quantitative approaches in Use in the United States to assess cancer Risks. Invited paper for the 2nd Conference of the Scientific Group on Methodology for the Safety Evaluation of Chemicals, World Health Organization, Rome, Italy, July 12-16, 1982. Published in Methods for Estimating Risks of Chemical Injury: Human and Nonhuman Biota and Ecosystems, SCOPE. 26:405-436.

Anderson, E.L., Ehrlich, A.M. 1985. New Risk assessment Initiatives in EPA. Toxicology and Industrial Health, Vol. 1, No. 4, pp. 7-22.

Anderson, E.L., Chu, M., Dourson, M., DeRosa, C. July 23-27, 1984. Methodology for ranking the degree of hazard associated with exposure to carcinogens and other toxic chemicals. In Proceedings of Symposium on Chemical Emergency Preparedness. Center for Human Health and Ecology, Pan American Health Organization, Metepec, Mexico.

Anderson, E.L., Carcinogen Assessment Group of the U.S. Environmental Protection Agency. 1983. The use of quantitative approaches to assess cancer risks. Risk Analysis.

Albert, R.E., Lewtas, J., Nesnow, S., Thorslund, T.W., Anderson, E.L. 1983. A comparative potency method for cancer risk assessment: Application to diesel particulate emissions. Risk Analysis.

Anderson, E.L. 1983. Are society's epidemiological needs being met? Invited paper for the Symposium on Epidemiologic Methods for Occupational and Environmental Health Studies, Washington, D.C., December 2-5, 1979. Published in Methods and Issues in Occupational and Environmental Epidemiology. Michigan. Ann Arbor Science Publishers.

Anderson, E.L. 1978. Risk assessment and regulatory approaches to carcinogens. Proceedings of the FDA Symposium of Risk/Benefit Decisions and the Public Health.

Albert, R.E., Train, R.E., Anderson, E.L. 1977. Rationale developed by the Environmental Protection Agency for the assessment of carcinogen Risks. J. Natl. Cancer Inst. 58:1537.

Hawkins, W.M., Lutz, R.E., Anderson, E.L. 1970. Tetrasubstituted 2,5-hydrofuranols and their anomerism. J. Org. Chem. 35:2934.

Hanson, R.B., Foley, P.J., Anderson, E.L., Aldridge, M.H. 1970. The thermal cleavage of selected aldehyde hydrazone salts. J. Org. Chem. 35:1735.

Foley, P.J., Anderson, E.L., Dewey, F.M. 1969. Synthesis of hydrazone salts. J. Chem. Engineer, Data 14:272.

INVITED PRESENTATIONS ON HEALTH RISK ASSESSMENT AND RELATED TOPICS

Keynote speaker. Environmental Risk Assessment: Past, Current, Future. Conference: Theories and Practices in toxicology and Risk Assessment. Sponsored by Tri-Services Toxicology

(AFRL/HEST, NHRC/TD, USACEHR), USACHPPM, AFSOR; USEPA, NCEA; ATSER, Division of Toxicology; NIOSH; and the FDA. Cincinnati, OH. April 15-18, 2002.

The Contrast Between Risk Assessment and Proof of Causality, and the Fundamental Principles of Evidence of Each. Workshop: Risk Assessment in the Context of Trade Disputes: How Well can the Scientific Principles Incorporated into the Resolution of Science-Based Trade Disputes? University of Michigan, Ann Arbor, MI. November 1, 2001.

Risk Assessment: The Evolution of a Science and its Use. Yale University. October 30, 2001.

The Challenge of Risk Assessment, Eco-Informa 2001: Environmental Risk and the Global Community. Argonne National Laboratory, Argonne, IL. May 14, 2001.

Environmental Forensics: Applying Effective Scientific Methods to Decrease Cost & Liability. IBC USA Third Annual Executive Forum. June 26 - 28, 2000. Washington, D.C.

Risk Assessment of Indoor Air Pollutants. The Fourth Princess Chulabhorn International Science Congress: Chemicals in the 21st Century. The Chulabhorn Research Institute. November 28 - December 2, 1999. Bangkok, Thailand.

Toxicology symposium: Agriculture and preservation of water quality: General principles of risk assessment. The Brazilian Society of Toxicology. March 15-18, 1999. Sao Paulo, Brazil.

Current issues in health risk assessment. October 26-28, 1998. International Society for Risk Analysis,

Health Risk Assessment: Current issues. Eleventh annual symposium. Williamsburg, Virginia.

Faculty, risk assessment and risk management in environmental law, ALI-ABA Course of Study. October 8-9, 1998.

Seminar on modern environmental management; risk assessment as a decision making tool. May, 1998. Salvador, Brazil.

The role of uncertainty, variability, and bias in environmental risk management. October 12-17, 1997. The eight Engineering Foundation conference on risk based decision making in water resource VIII, Santa Barbara, California.

Overview of carcinogen and noncarcinogen risk assessment: Historical perspective. October 6-8, 1997. International Society for Risk Analysis, Health Risk Assessment: Current issues. Tenth annual symposium.

Coming of age - Risk based environmental decision making. September 27, 1997. The McLain program in environmental studies, Washington College.

Applications of quantitative risk assessment to environmental health. Guest faculty for the 1997 summer institute in risk management in environmental health and protection, New York University, New York, NY.

Risk-based analysis. March 20, 1997. Second annual environmental law forum, Pennsylvania Bar Institute, Harrisburg, Pennsylvania.

Risk-based decision making in the environmental arena: An overview. March 13-15, 1997. 26th annual conference on environmental law. American Bar Association, Section of Natural Resources, Energy, and Environmental Law. Keystone, Colorado.

Analysis of risks to human health. November, 1996. Washington Operations Research/Management Science Council, topics in risk analysis, Arlington Campus of George Mason University, Arlington, Virginia.

Sources of information for uncertainty analyses: case studies, risk assessment issues - The probabilistic approach. March 28, 1996. University of California Extension, Santa Barbara, California.

Overview of risk assessment and risk management as a tool for environmental decision making, risk assessment, risk management and risk communication: Expanding the dialogue on environmental management - An international seminar. November 7-9, 1995. Sao Paulo, Brazil.

Origins of quantitative risk assessment for cancer. November 4, 1995. International symposium sponsored by the collegium ramazzini on preventive strategies for living in a chemical world. Washington, DC.

Risk-based decision making engineering foundation conference. Santa Barbara, California. October 13, 1995.

Overview of carcinogen and noncarcinogen risk assessment methods. August 29, 1994. Society for Risk Analysis annual course on new horizons in risk assessment. Arlington, Virginia.

Twelfth institute in risk management in environmental health and protection. May 17, 1994. Guest faculty. New York University, New York, NY.

Risk assessment in environmental decisions. July 21, 1993. Environmental policy issues seminar, U.S. Office of Personnel Management. Denver, Colorado

Crossroads of humanity series, round table forum. July 18-21, 1993. The Medical University of South Carolina, Kiawah Island, South Carolina.

Risk characterization, environmental and occupational risk assessment: what it means to the mining industry. July 13, 1993. The American Mining Congress, Fairfax, Virginia.

Quantitative risk assessment: Introduction to approaches and methods. June 2, 1993. Guest faculty, eleventh annual summer institute in risk management in environmental health and protection, New York University, New York, NY.

Using risk assessment to deal with health issues that would be barriers to sustainable development. May 26, 1993. Governor's Conference, from Rio to the Capitols: State strategies for sustainable development. Louisville, Kentucky.

Risk assessment guidance at Superfund sites. April 13, 1993. Chemical Manufacturers Association's superfund health risk assessment task group and remedy selection work group. Washington, DC.

Quantitative risk assessment II: Models and methods. June 9, 1992. Guest faculty, Tenth annual summer institute in risk management in environmental health and protection, New York University, New York, NY.

Overview of carcinogen and noncarcinogen risk assessment methods. April 13, 1992. Society for Risk Analysis annual course on new directions in risk assessment, Arlington, Virginia.

Human health assessment: An overview. April 1992. Seminar on social, economic, biologic and legal basis for dealing with environmental problems. Santiago, Chile.

Cancer risk assessments: An overview. October 7-11, 1991. Advanced research workshop on oncogene and transgenics correlates of cancer risk assessments, North Atlantic Treaty Organization and U.S. National Science Foundation. Athens, Greece.

Quantitative risk assessment (with applications to hazardous waste management). June, 1991. Ninth annual summer institute in risk management in environmental health and protection, New York University, Guest faculty.

Advances in carcinogen risk assessment with potential lessons for risk assessment for reproductive effects. May, 1991. Symposium on risk assessment of prenatally-induced adverse effects, Berlin, Germany.

New directions in risk assessment. May, 1991. Workshop, Society for Risk Analysis, Bethesda, Maryland.

Risk assessment approaches and application for regulation of exposure to potential carcinogens. March, 1991. U.S.-Japan cooperative cancer research program seminar on scientific basis for carcinogenic risk assessment of experimental carcinogens, Kauai, Hawaii.

Annual meeting, February, 1991. American Association for the Advancement of Science. Women in Science, Washington, DC.

Key-note speaker. Professional conference on industrial hygiene: Risk assessment-future directions and impact on health and environment. October, 1990. American Academy of Industrial Hygiene, Vancouver, BC, Canada.

Changing roles. October, 1990. 17th annual Michigan Industrial Hygiene Society mini-conference, Troy, Michigan.

Session Chairman. June, 1990. HAZ MAT/International '90, Toxic air pollutants: Current issues. Atlantic City, New Jersey.

Risks associated with hazardous waste. May, 1990. The Wharton School of the University of Pennsylvania, Philadelphia, Pennsylvania.

New directions in carcinogen risk assessment. May, 1990. Workshop, Society for Risk Analysis, Bethesda, Maryland.

Risk assessment and risk management. October, 1989. Key-note speaker. International symposium and the first pan pacific cooperative symposium on industrialization and emerging environmental health issues. Kitakyushu, Japan.

International symposium on environmental risk assessment and risk management. October, 1989. Seoul, Korea,

Conference on the price of zero risk and zero waste. October, 1989. The Wharton School of the University of Pennsylvania, Philadelphia, Pennsylvania.

Blue ribbon international symposium on incineration of municipal solid waste. September, 1989. United States Conference of Mayors, Washington, DC.

Comparison of traditional health risks and risks associated with industrial development. July, 1989. Conference on environmental mutagens, Guadalajara, Mexico.

Conducted summer session on science, risk and the law of toxics. June, 1989. Vermont Law School 1989 Summer Session, South Royalton, Vermont.

Seventh annual summer institute in risk management in environmental health and protection. May 31, 1989. Guest faculty. New York University, New York, NY.

Risk assessment of non-ionizing radiation. April 13, 1989. Electromagnetic Energy Policy Alliance annual meeting, Alexandria, Virginia.

The risk analysis process. April 3-5, 1989. Workshop on Carcinogen Risk Assessment, Society for Risk Analysis, Washington, DC.

Anderson, E.L., Thorslund, T.W., Chrostowski, P.C., Charnley, G. 1988. Scientific trends in risk assessment research. Association of the Bar of the City of New York, Environmental Law Committee, New York, NY.

Conference on Risks of Toxic Substances in developing countries: Implications for women and children. November 18-20, 1988. Bangkok, Thailand.

A defense view of risk assessment. October 21, 1988. 1988 fall annual meeting. American Bar Association, Section of Litigation. J.W. Marriott Hotel, Washington, DC.

The 1988 Washington conference on risk assessment. September, 1988. The Center for Energy and Environmental Management, Alexandria, Virginia.

Lecture on models for dose-response estimation and low-dose extrapolation. June, 1988. Sixth annual summer institute in risk management in environmental health and protection, New York University Graduate School of Public Administration, New York City.

Seminar on risk assessment of resource recovery plants. June, 1988. 1988 United States Conference of Mayors annual conference, Salt Lake City, Utah.

Limitations of the risk assessment process: Factors which affect the utility and credibility of the assessment process. June, 1988. Session Chairman. Gordon conferences, Wolfeboro, New Hampshire.

Scientific trends in risk assessment research. June, 1988. International symposium on chemical mixtures: Risk assessment and management. Cincinnati, Ohio.

Participated as rapporteur at the only one Earth forum series. May, 1988. Managing hazardous materials. Workshop on PCBs, dioxins, and similar materials. Rene Dubos Center for Human Environments, New York, NY.

Risk assessment issues associated with cleaning up inactive hazardous waste sites. May, 1988. Conference on risk assessment and risk management strategies for hazardous waste storage and disposal problems. Wharton School, University of Pennsylvania, Philadelphia, Pennsylvania.

Seminar on recent trends in health risk assessment: Impact on risk assessment of resource recovery projects. March, 1988. 1988 United States Conference of Mayors annual conference, Washington, DC.

The risk analysis process. March, 1988. Workshop on carcinogen risk assessment, Society for Risk Analysis. Washington, DC.

Lecture on scientific trends in risk assessment research. February, 1988. Association of the Bar of the City of New York seminar on risk assessment in environmental law. New York, NY.

Risk assessment of suspect carcinogens. Keynote speaker. 2nd U.S.-Japan workshop on risk assessment/risk management, Osaka, Japan.

Perspective on risk assessment of carcinogens. October, 1987. Banbury conference on new directions in the qualitative and quantitative aspects of carcinogen risk assessment, Cold Springs Harbor, NY.

Lecture on use of risk assessment in the evaluation of the public health impacts of toxic chemicals. Risk analysis in environmental and occupational health with emphasis on carcinogenesis. September, 1987. Harvard School of Public Health, Cambridge, Massachusetts.

Lecture on carcinogen risk assessment. June, 1987. New York University, Graduate School of Public Administration.

Lecture on extension of risk assessment methodology to biotechnology applications. June, 1987. NATO advanced research workshop on risk analysis approaches for environmental releases of genetically engineered organisms, Rome, Italy.

Panel discussion: Risk assessment and insurability issues. May, 1987. International symposium on forecasting. Boston, Massachusetts.

Lecture on the risk analysis process. April, 1987. Workshop on Carcinogen assessment, Society of Risk Analysis, National Academy of Sciences. Washington, DC.

Comments on medical issues in toxic tort cases, risk assessment, cancer, and immunological injuries. April, 1987. ABA Risk Assessment Panel. American Bar Association Section of Natural Resources Law. Chicago, Illinois.

Roundtable discussion on risk communication and the public's right to know. March, 1987. International Life Sciences Institute, Advisory Panel for Risk Communication.

Panel member, The role of risk assessment in dealing with environmental pollution problems. March, 1987. The Wharton School of the University of Pennsylvania, Philadelphia, Pennsylvania.

Seminar on risk assessment and risk management. January 20, 1987. Meeting of Subcommittee on Information Coordination (SIC) of the Committee to Coordinate Environmental Health and Related Programs. National Institutes of Health.

The assessment of air contaminants: The science vs. the art. December 4, 1986. HazMat West Conference, Long Beach, California.

Thorslund, T.W., Charnley, G., Anderson, E.L. December 1-3, 1986. Innovative use of toxicological data to improve cost-effectiveness of waste cleanup. Presented at Superfund '86: Management of uncontrolled hazardous waste sites, Washington, DC.

Seminar series on risk assessment. November 19, 1986. The Center for Energy and Environmental Management. Secaucus, New Jersey.

Research needs to support risk assessment. In retrospect. November 17, 1986. Annual meeting of the American College of Toxicology, Philadelphia, Pennsylvania.

Risk assessment and incineration. November 12, 1986. Michigan Air Pollution Control Association, Dearborn, Michigan.

Risk assessment of biologically altered agents. November 10-11, 1986. Society for Risk Analysis Annual conference. Boston, Massachusetts.

Exposure assessment in a regulatory setting: The significance of protective assumptions in the absence of real data. October 30, 1986. American Petroleum Institute, Houston, Texas.

Workshop on evaluating toxic tort litigation liabilities. October 29, 1986. Natural Resources Section of the American Bar Association, Arlington, Virginia.

Workshop on pragmatics of risk assessment. October 28, 1986. Society of Toxicology, Bethesda, Maryland.

Seminar series. The Center for Energy and Environmental Management. October 27, 1986. Dallas, Texas.

Risk assessment forum on risk assessment and the workplace: Policy and practice. October 24, 1986. American Industrial Hygiene Association, George Mason University, Fairfax, VA.

Risk assessment of chemical waste. October 16, 1986. Hazardous Waste Conference, Pennsylvania Chamber of Commerce, Valley Forge, PA.

Lecture series on risk analysis in environmental health with emphasis on carcinogenesis. September 4, 1986. Harvard School of Public Health's Continuing Education Program, Boston, Massachusetts.

Risk assessment at uncontrolled hazardous waste sites. August 25, 1986. American Institute of Chemical Engineers Annual Meeting, Boston, Massachusetts.

Risk assessment and hazardous waste management: The impact of biomedical and exposure assumptions on meeting acceptable concentration goals. August 14, 1986. HAZTECH International, Denver, Colorado.

Recent advances in risk assessment. June, 1986. The fourth annual summer Institute in Risk Management in Environmental Health and Protection, New York University Graduate School of Public Administration, New York, NY.

Risk assessment/risk management applied to air toxics. June 22, 1986. Air Pollution Control Association, Minneapolis, Minnesota.

Risk assessment/risk management training session. June 6, 1986. Maine Board of Environmental Protection, Portland, Maine.

Workshop on research needs in risk analysis. June 2, 1986. National Research Council, National Academy of Science, Washington, DC.

Conducted course on hazardous chemical management and emergency response. May 20-23, 1986. First meeting of Caribbean Countries on toxic materials and pesticides, Pan American Health Organization, Bridgetown, Barbados.

Chemical risk assessment: Methods and applications. May 2, 1986. University of California, Los Angeles, Los Angeles, CA.

Cancer risk assessment in a regulatory setting. April 14-16, 1986. Annual meeting of the Operations Research Society of America, Los Angeles, CA.

The Risk analysis process. Workshop on risk assessment/risk management: Carcinogenesis. April 7-9, Society for Risk Analysis, National Academy of Science, Washington, DC. 1986.

Chemical risk assessment: the need for research. March 12, 1986. DuPont's Haskell Laboratories, Wilmington, DE.

Roundtable discussions on risk communication and the public's right to know. December 15, 1986. Risk Science Institute, Atlanta, GA.

Risk assessment and risk management of cadmium exposures in the U.S. February 4-6, 1986. Fifth international conference on cadmium, International Lead/Zinc Research Organization, San Francisco, CA.

Risk assessment of toxic chemicals: A decade of experience. February 1986. Speaker for the Federal Water Quality Association and the Water Pollution Control Federation.

Annual environmental information exchange. December, 1985. Sponsored by the American Air Pollution Control Association, the U.S. Environmental Protection Agency, and the Society for Mechanical Engineers. Research Triangle Park, NC.

Risk assessment methods for uncontrolled releases of chemicals. October, 1985. Conference on risk analysis in developing countries. World Health Organization and National Science Foundation, Hyderabad, India.

Presented President's address on a decade in risk assessment and a paper on risk assessment as it is practiced at the federal and state level, with emphasis on areas for improvement. October, 1985. Annual Meeting on Improving Risk Management, Society for Risk Analysis, Alexandria, Virginia.

Lecture series on carcinogen risk assessment and risk management. September, 1985. Harvard School of Public Health's Continuing Education Program, Boston, Massachusetts.

Symposium on risk assessment. Chemical Manufacturers Association. September, 1985. Washington, DC.

Risk assessment methods applied to issues in developing countries: environmental health risk assessment. August, 1985. Pan American Health Organization, Mexico City, Mexico.

The use of risk assessment at the state level. July, 1985. National Governors Association Council on Environmental Health. Washington, DC.

Assessing risk associated with chemicals. July, 1985. The Toxicology Forum, Aspen, Colorado. Research needed to support risk assessment of exposures at superfund and hazardous waste sites. July, 1985. The Centers for Disease Control, Atlanta, Georgia.

The use of risk assessment in the federal government. June 1985. Distinguished Scholars Program, American Association for the Advancement of Science. Washington, DC.

Lecture series on risk assessment and public health. June, 1985. Third annual summer institute, Graduate School of Public Health, New York University, New York, NY.

Symposium on health and environmental risk assessment. June, 1985. Brooks Institute, Washington, DC.

1985 annual summer symposium on the evaluation of health data for toxic chemicals. May, 1985. Mid-Year Meeting on Risk assessment, Chemical Specialties Manufacturers Association, Chicago, Illinois.

Symposium on risk assessment. May, 1985. American Industrial Health Council, Washington, DC.

Conference on risk assessment. May, 1985. The American Medical Association, Atlanta, GA.

Risk assessment methods. May, 1985. Mid-Year briefing program of the American Industrial Health Council, Washington, DC.

Risk assessment of regulatory implications. May 1985. 14th Annual conference on the environment, risk assessment and the law. Airlie House conference, The American Bar Association, Warrenton, VA.

Risk assessment of agricultural chemicals. May, 1985. Public Health and Toxicology Committee Meeting, National Agricultural Chemicals Association, Washington, DC.

Risk assessment of potential effects associated with release of genetically altered mechanisms. April, 1985. Banbury Conference on Genetically Altered Viruses and the Environment, sponsored by EPA, Banbury Center, Cold Spring Harbor Laboratory, Long Island, NY.

Executive workshop on risk analysis in the federal regulatory process. April, 1985. American Society of Mechanical Engineers, Washington, DC.

Risk analysis: Invited lecture series on health risk assessment. April, 1985. Stanford University, Palo Alto, Stanford, CA.

Prevention 85: Assessing risks in a hazardous world. March 1985. Atlanta, GA.

Symposium on acceptable risks/society's gamble. Public television series. March, 1985. Rutgers University, New Brunswick, NJ.

Toxics management in the Chesapeake bay. March, 1985. Seminar sponsored by the Virginia Institute of Marine Science and the Virginia Water Pollution Control Association. Gloucester Point, VA.

Member, Board on Toxicology and Environmental Health Hazards. March, 1985. National Research Council/National Academy of Sciences. Washington, DC.

Symposium on new issues in regulatory toxicology and health risk assessment. March, 1985. Society of Toxicology, San Diego, CA.

Semi-annual meeting of committee on toxicology. March, 1985. National Research Council/National Academy of Sciences. Washington, DC.

Chemical product risk reduction. February, 1985. Seminar sponsored by Executive Enterprises, Washington, DC.

Seminar on understanding environmental risks. January, 1985. Department of Environmental Toxicology and Public Service Research and Dissemination, University of California, Davis, California.

National symposium on chemical emergencies. December, 1984. Pan American Health Organization, Sao Paulo, Brazil.

U.S.-Japanese workshop on risk assessment/risk management. October, 1984. Vanderbilt University and Tsukuba University under the U.S.-Japanese Cooperative Program, Tsukuba Science City, Japan.

Lectured on risk assessment. November, 1984. Institute of Public Health, Tokyo, Japan.

Lectured on risk assessment. November, 1984. Mie University School of Medicine. Tsu City, Mie-Ken, Japan.

Risk assessment/risk management seminar. November, 1984. Sponsored by the Institute of Occupational and Environmental Health, Japan School of Medicine. Kitakyushu, Japan.

Conducted risk assessment/risk management Seminar. November, 1984. Sponsored by the Republic of Korea Environmental Agency. Seoul, Korea.

Lectured on risk assessment. November, 1984. Institute of Environmental Research, Yonsei University School of Medicine. Seoul, Korea.

Lectured on risk assessment. November, 1984. Japanese Environmental Agency. Tokyo, Japan.

The future of formaldehyde. November, 1984. Seminar sponsored by the Consumer Federation of America. Washington, DC.

Symposium on risk assessment. October, 1984. EPA. Cincinnati, Ohio.

Seminar on risk analysis on environmental health with emphasis on carcinogenesis. September, 1984. Harvard School of Public Health. Boston, Massachusetts.

Conference on risk analysis. August, 1984. Advisory Council Seminar, Electric Power Research Institute. Monterey, CA.

Symposium on chemical emergency preparedness. July, 1984. Pan American Center for Human Ecology and Health, Pan American Health Organization. Metepec, Mexico.

Summer institute in risk management. June, 1984. New York University. New York, New York.

Risk management and environmental decisions. May, 1984. Federal Water Quality Association, Washington, DC.

Lecture on risk assessment. April, 1984. Wharton School of Business, University of Pennsylvania. Philadelphia, PA.

Executive session on the environment, regulation, and risk. March, 1984. Harvard University. Boston, Massachusetts.

11th annual energy conference on risk, media, and the public. February, 1984. WATTec. Knoxville, TN.

Principles in evaluating carcinogenesis data for environmental pollutants. February 16, 1983. Food Safety/Risk Assessment Committee, International Life Sciences Institute. Washington, DC.

Carcinogenesis from the environment to the gene oncogenesis. November 19-21, 1982. Cold Spring Harbor Laboratory. Long Island, NY.

Risk assessment and public policy. November 18, 1982. Symposium on Health Risk Assessment. Sponsored by the National Association of Science Writers and Women in Government, National Academy of Sciences, Washington, DC.

The evolutionary process of carcinogen risk assessment in EPA: Future trends. November 8-9, 1982. Conference on the Reagan/Gorsuch EPA--Its Impact on Industry. Sponsored by the Center for Energy and Environmental Management and "Inside EPA." Washington, DC.

Risk assessment for environmental toxicants. November 5, 1982. Science and Technology Conference for Government Executives, The Brooks Institute. Williamsburg, VA.

Risk for progeny associated with prenatal exposures to chemicals, editor. World Health Organization meeting, Geneva, Switzerland. October 1982.

Symposium on risk assessment. Speaker and session chairman. Annual Meeting of the American Chemical Society, Kansas City, KS.

The Scientific Group on Methodology for the Safety Evaluation of Chemicals Within the Framework of the International Program for chemical Safety. Speaker and workshop participant. July 12-16, 1982. World Health Organization. Leningrad, USSR.

Practical application in risk assessment. June 29, 1982. American Mining Congress Risk Assessment Seminar. University of California, Berkeley, CA.

Low dose high consequence risk assessment. June 18, 1982. Panel Member at annual Meeting of the Society for Risk Analysis.

Practical applications of risk analysis: The Environmental Protection Agency experience. June 14, 1982. The Food and Drug Law Institute. Washington, DC.

Workshop participant to advise the Georgetown University Medical Center on issues relevant to setting up their Health Policy Institute. May 2, 1982. Belmont, MD.

Issues and concepts of risk assessment, Session chairman. March 14-17, 1982. Annual meeting of the Biostatistics Society, Texas A&M University, San Antonio, TX.

Participant and chapter editor for risk assessment for World Health Organization Workshop on methods for the integrated evaluation of risks for progeny associated with prenatal exposure to chemicals, November 30-December 6, 1981. Prague, Czechoslovakia.

The Role of risk assessment in the regulation of carcinogens. November 3-4, 1981. University Center for International Studies, University of Pittsburgh, PA.

EPA risk assessment for carcinogens. October 13, 1981. Assembly of Life Sciences Committee on the Institutional Means for Assessment of Risks to Public Health. Washington, DC.

Workshop on low-dose extrapolation, biological and statistical implication of the ED01 study and related data base. September 13-16, 1981. Mt. Sterling, Ohio.

Strengths and weaknesses of current risk assessment methods. May 1, 1981. Conference on Risk Assessment in Regulating Health and Safety. The Brooks Institute, Washington, DC.

Risk assessment as a basis for regulations. April 8, 1981. University of North Carolina, Chapel Hill, North Carolina.

Risk assessment. February 24, 1981. Seminar for Presidential Management Program. , U.S. Environmental Protection Agency.

The use of scientific data in evaluating environmental carcinogens: February 11, 1981. The need for balance. Symposium on Genotoxic Effects of Airborne Agents. Brookhaven National Laboratory. Upton, NY.

Symposium on health risk analysis, Session chairman. October 27-30, 1980. Oak Ridge National Laboratory Life Sciences Series, Gatlinburg, TN,

Risk assessment: A look to the future. July, 1980. Gordon Conference. Plymouth, NH.

Quantitative risk criteria and goals for public health protection. December 1979. Nuclear Regulatory Commission, Advisory Committee on Reactor Safeguards. Washington, DC.

The role of risk assessment in the regulation of carcinogens. September, 1979. NATO Advanced Research Institute on in vitro Toxicity Testing of Environmental Agents. Monte Carlo, Monaco.

In addition, from 1979 to 1981, invited lecturer on cancer and risk assessment policies at a number of universities including, University of Cincinnati, January 5, 1979; Hood College, November 1979; University of Wisconsin, November 1979; Williams College, February 1981; University of North Carolina, February 1981; North Carolina State University, October 1981.

Appendix B – List of Depositions and Trial Testimony for Dr. Elizabeth Anderson

- 1.) September 27, 2002, Deposition in United States of America vs. W.R. Grace Company, W.R. Grace Company – Conn., and Kootenai Development Corporation, District of Montana, Missoula Division (Civil No. 01-72-M-DWM).
- 2.) May 14, 2002, Deposition in United States of America vs. Union Corporation Metal Bank, United States District Court, Eastern District of Pennsylvania (Civil No. 80-1589).
- 3.) June 19, 2001, Deposition in Interfaith Community Organization , et al, Plaintiffs, vs. Honeywell International, Inc., etc., et al, Defendants. United States District Court, For the District of New Jersey (Civil No. 96-2097).

Appendix C – Compensation for Dr. Elizabeth Anderson

My billing rate was \$275 per hour for preparing this report, and at 1.5 times that rate (\$412.50) for preparation for deposition and trial testimony, and for deposition and trial testimony.

Table D-1
Exposure Factors

Residential								
Scenario Number / Activity	Scenario	Time Spent in Activity (hrs/day)	Exposure Frequency (days/yr)	Exposure Duration (Years)	Total Events *	Total Hours *	Time Weighting Factor	
1 / Moving boxes	Typical	0.5	2	9	18	9	0.0000147	
1 / Moving boxes	High-end	1	4	30	120	120	0.0001957	
2 / Small area clearance	Typical	0.5	1	2	2	1	0.0000016	
2 / Small area clearance	High-end	1.5	1	5	5	8	0.0000122	
3 / Small area clearance & fan installation	Typical	3	1	1	1	3	0.0000049	
3 / Small area clearance & fan installation	High-end	5	1	2	2	10	0.0000163	
4 / Large area clearance	Typical	1	1	1	1	1	0.0000016	
4 / Large area clearance	High-end	2	1	2	2	4	0.0000065	
5 / Removing VAI	Typical	8	1	1	1	8	0.0000130	
5 / Removing VAI	High-end	12	1	1	1	12	0.0000196	

Contractor								
Activity	Scenario	Time Spent in Activity (hrs/day)	Exposure Frequency (days/yr)	Exposure Duration (Years)	Total Events *	Total Hours *	Time Weighting Factor	
2 / Small area clearance	Typical	0.5	0.29	11	3	2	0.0000026	
2 / Small area clearance	High-end	1.5	0.75	45	34	51	0.0000826	
3 / Small area clearance & fan installation	Typical	3	0.29	11	3	10	0.0000156	
3 / Small area clearance & fan installation	High-end	5	0.75	45	34	169	0.0002752	
4 / Large area clearance	Typical	1	0.29	11	3	3	0.0000052	
4 / Large area clearance	High-end	2	0.75	45	34	68	0.0001101	
5 / Removing VAI	Typical	8	0.29	11	3	26	0.0000416	
5 / Removing VAI	High-end	12	0.75	45	34	405	0.0006605	

* Values presented have been rounded

Contractor Exposure Frequency (EF)			
	Typical	High-End	Note
Homes with VAI	940,000	940,000	Versar 1982 (1)
Total Homes	81,094,000	81,094,000	US DOC 1996 (2)
Frequency of VAI homes	1.16%	3.0%	calculated/assumed
Working days / year	250	250	assumed
Days working in VAI home / year (VAI-home EF)	2.90	7.50	calculated (3)
Probability of Contact with VAI in VAI home	10%	10%	assumed
Days contacting VAI / year (VAI EF)	0.29	0.75	calculated

1) Information based on *Exposure Assessment for Asbestos-Contaminated Vermiculite, Interim Final Report*, Versar Inc., February 18, 1982

2) Total homes based on information in *Statistical Abstract of the United States 1996*, US Department of Commerce - Bureau of the Census, October 1996. The value used represents sum of homes in the following categories: "single family detached" (64,283,000 units), "single family attached" (6,079,000 units) and "2 to 4 units" (10,732,000 units).

3) The VAI-home EF is the frequency of VAI homes multiplied by the number of working days per year

Table D-2
Resident Risk (Lees)

Residential		Exposure Concentration (fibers per cubic centimeter PCME) / Risk							
Activity	Scenario	Data	Time Weighting Factor	Worker (f/cc)	Risk	Helper (f/cc)	Risk	Bystander (f/cc)	Risk
Moving boxes	Typical	Lees - avg. of scenarios D, K, S	0.0000147	0.000050	1.7E-09	0	0.0E+00	0	0.0E+00
Moving boxes	High-end	Lees - max of scenarios D, K, S	0.0001957	0.0030	1.4E-07	0	0.0E+00	0	0.0E+00
Small area clearance	Typical	Lees - avg. of scenarios F and M	0.0000016	0.099	3.7E-08	0.0073	2.7E-09	0	0.0E+00
Small area clearance	High-end	Lees - max of scenarios F and M	0.0000122	0.21	5.8E-07	0.029	8.2E-08	0	0.0E+00
Small area clearance & fan installation	Typical	Lees - avg of scenario H	0.0000049	0	0.0E+00	0	0.0E+00	0	0.0E+00
Small area clearance & fan installation	High-end	Lees - max of scenario H	0.0000163	0	0.0E+00	0	0.0E+00	0	0.0E+00
Large area clearance (1)	Typical	Lees - avg. of scenarios O and Q	0.0000016	0.017	6.2E-09	0.0029	1.1E-09	0	0.0E+00
Large area clearance (2)	High-end	Lees - max of scenarios O and Q	0.0000065	0.041	6.2E-08	0.0038	5.6E-09	0	0.0E+00

1) Exposure concentration based on 0.5 hr of large area clearance and 3.5 hours of moving boxes

2) Exposure concentration based on 1 hr of large area clearance and 7 hours of moving boxes

Table D-3
Resident Risk (WA Study)

		Exposure Concentration (fibers per cubic centimeter PCME) / Risk							
Residential		Assumed Exposure Scenario	Scenario	Data	Time Weighting Factor	Worker (f/cc)	Risk	Helper (f/cc)	Risk
Cleaning Stored Items	Moving boxes	Typical	Ewing 2003	0.0000147	0	0.0E+00	0	0.0E+00	0
Cleaning Stored Items	Moving boxes	High-end	Ewing 2003	0.0001957	0	0.0E+00	0	0.0E+00	0
Ceiling Penetration	Small area clearance & fan inst.	Typical	Ewing 2003	0.0000049	0.050	5.6E-08	0.11	1.3E-07	4.3E-07
Ceiling Penetration	Small area clearance & fan inst.	High-end	Ewing 2003	0.0000163	0.050	1.9E-07	0.11	0.0E+00	0
Moving Aside VAI - Grace Method	Large area clearance	Typical	Ewing 2003	0.0000016	0.52	2.0E-07	0	0.0E+00	0
Moving Aside VAI - Grace Method	Large area clearance	High-end	Ewing 2003	0.0000065	0.52	7.8E-07	0	0.0E+00	0
Moving Aside VAI - Homeowner Method	Large area clearance	Typical	Ewing 2003	0.0000016	0.57	2.1E-07	0.096	3.6E-08	0.096
Moving Aside VAI - Homeowner Method	Large area clearance	High-end	Ewing 2003	0.0000065	0.57	8.5E-07	0.096	1.4E-07	0.096
Shop Vac Removal VAI from top perimeter wall cavities	Small area clearance	Typical	Ewing 2003	0.0000016	0	0.0E+00	0.072	2.7E-08	0.072
Shop Vac Removal VAI from top perimeter wall cavities	Small area clearance	High-end	Ewing 2003	0.0000122	0	0.0E+00	0.072	2.0E-07	0.072

Table D-4
Contractor Risk (Lees)

Contractor	Activity	Scenario	Data	Exposure Concentration (fibers per cubic centimeter PCME) / Risk					
				Time Weighting Factor	Worker (fib/cc)	Risk	Helper (fib/cc)	Risk	Bystander (fib/cc)
Small area clearance	Typical	Lees - avg. of scenarios F and M	0.0000026	0.099	5.9E-08	0.0073	4.3E-09	0	0.0E+00
Small area clearance	High-end	Lees - max of scenarios F and M	0.0000826	0.099	1.9E-06	0.0073	1.4E-07	0	0.0E+00
Small area clearance & fan installation	Typical	Lees - avg of scenario H	0.0000156	0	0.0E+00	0	0.0E+00	0	0.0E+00
Small area clearance & fan installation	High-end	Lees - max of scenario H	0.0002752	0	0.0E+00	0	0.0E+00	0	0.0E+00
Large area clearance (1)	Typical	Lees - avg. of scenarios O and Q	0.0000052	0.017	2.0E-08	0.0029	3.5E-09	0	0.0E+00
Large area clearance (2)	High-end	Lees - max of scenarios O and Q	0.000101	0.017	4.2E-07	0.0029	7.4E-08	0	0.0E+00

1) Exposure concentration based on 0.5 hr of large area clearance and 3.5 hours of moving boxes

2) Exposure concentration based on 1 hr of large area clearance and 7 hours of moving boxes

Table D-5
Contractor Risk (WA Study)

		Exposure Concentration (fibers per cubic centimeter PCME) / Risk						
Residential	Assumed Exposure Scenario	Scenario	Data	Time Weighting Factor	Worker (f/cc)	Risk	Helper (f/cc)	Risk
Ceiling Penetration	Small area clearance & fan inst.	Typical	Ewing 2003	0.0000156	0.050	1.8E-07	0.11	4.1E-07
Ceiling Penetration	Small area clearance & fan inst.	High-end	Ewing 2003	0.0002752	0.050	3.2E-06	0.11	7.2E-06
Moving Aside VAI - Grace Method	Large area clearance	Typical	Ewing 2003	0.0000052	0.521	6.2E-07	0	0.0E+00
Moving Aside VAI - Grace Method	Large area clearance	High-end	Ewing 2003	0.0001101	0.521	1.3E-05	0	0.0E+00
Moving Aside VAI - Homeowner Method	Large area clearance	Typical	Ewing 2003	0.0000052	0.57	6.8E-07	0.096	1.1E-07
Moving Aside VAI - Homeowner Method	Large area clearance	High-end	Ewing 2003	0.0001101	0.57	1.4E-05	0.096	2.4E-06
Shop Vac Removal VAI from top perimeter wall cavities	Small area clearance	Typical	Ewing 2003	0.0000026	0	0.0E+00	0.072	4.3E-08
Shop Vac Removal VAI from top perimeter wall cavities	Small area clearance	High-end	Ewing 2003	0.00000826	0	0.0E+00	0.072	1.4E-06

Table D-6
Resident Risk with Cleavage Fragments Included (Lees)

Activity	Residential	Scenario	Data	Exposure Concentration (fibers per cubic centimeter PCME) / Risk					
				Time Weighting Factor	Worker (f/cc)	Risk	Helper (f/cc)	Risk	Bystander (f/cc)
Moving boxes	Typical	Lees - avg. of scenarios D, K, S	0.0000147	0.038	1.3E-07	0	0.0E+00	0.00076	2.6E-09
Moving boxes	High-end	Lees - max of scenarios D, K, S	0.0001957	0.14	6.1E-06	0	0.0E+00	0.0046	2.1E-07
Small area clearance	Typical	Lees - avg. of scenarios F and M	0.0000016	0.58	2.2E-07	0.030	1.1E-08	0	0.0E+00
Small area clearance	High-end	Lees - max of scenarios F and M	0.0000122	0.68	1.9E-06	0.071	2.0E-07	0	0.0E+00
Small area clearance & fan installation	Typical	Lees - avg. of scenario H	0.0000049	0.22	2.5E-07	0.00079	8.9E-10	0	0.0E+00
Small area clearance & fan installation	High-end	Lees - max of scenario H	0.0000163	0.24	8.9E-07	0.0016	5.9E-09	0	0.0E+00
Large area clearance (1)	Typical	Lees - avg. of scenarios O and Q	0.0000016	0.21	7.9E-08	0.029	1.1E-08	0.00067	2.5E-10
Large area clearance (2)	High-end	Lees - max of scenarios O and Q	0.0000065	0.36	5.4E-07	0.045	6.8E-08	0.0040	6.0E-09

1) Exposure concentration based on 0.5 hr of large area clearance and 3.5 hours of moving boxes

2) Exposure concentration based on 1 hr of large area clearance and 7 hours of moving boxes

Table D-7
Resident Risk with Cleavage Fragments Included (WA Study)

Residential		Exposure Concentration (fibers per cubic centimeter PCME) / Risk			
Activity	Scenario	Data	Time Weighting Factor	Worker (f/cc)	Risk
Cleaning Stored Items	Typical	Ewing 2003	0.0000147	0	0.0E+00
Cleaning Stored Items	High-end	Ewing 2003	0.0001957	0	0.0E+00
Ceiling Penetration	Typical	Ewing 2003	0.0000049	0.54	6.1E-07
Ceiling Penetration	High-end	Ewing 2003	0.000163	0.54	2.0E-06
Moving Aside VAI - Grace Method	Typical	Ewing 2003	0.0000016	4.48	1.7E-06
Moving Aside VAI - Grace Method	High-end	Ewing 2003	0.0000065	4.48	6.7E-06
Moving Aside VAI - Homeowner Method	Typical	Ewing 2003	0.0000016	9.57	3.6E-06
Moving Aside VAI - Homeowner Method	High-end	Ewing 2003	0.0000065	9.57	1.4E-05
Shop Vac Removal VAI from top perimeter wall cavities	Typical	Ewing 2003	0.0000016	0.69	2.6E-07
Shop Vac Removal VAI from top perimeter wall cavities	High-end	Ewing 2003	0.000122	0.69	1.9E-06

Table D-8
Contractor Risk with Cleavage Fragments Included (Lees)

Contractor	Activity	Scenario	Data	Exposure Concentration (fibers per cubic centimeter PCME) / Risk						
				Time Weighting Factor	Worker (f/cc)	Risk	Helper (f/cc)	Risk	Bystander (f/cc)	Risk
Small area clearance	Typical	Lees - avg. of scenarios F and M	0.0000026	0.58	3.5E-07	0.030	1.8E-08	0	0.0E+00	
Small area clearance	High-end	Lees - max of scenarios F and M	0.0000826	0.58	1.1E-05	0.030	5.7E-07	0	0.0E+00	
Small area clearance & fan installation	Typical	Lees - avg of scenario H	0.0000156	0.22	8.0E-07	0.00079	2.8E-09	0	0.0E+00	
Small area clearance & fan installation	High-end	Lees - max of scenario H	0.0002752	0.22	1.4E-05	0.00079	5.0E-08	0	0.0E+00	
Large area clearance (1)	Typical	Lees - avg. of scenarios O and Q	0.0000052	0.21	2.5E-07	0.029	3.4E-08	0.0006672	8.0E-10	
Large area clearance (2)	High-end	Lees - max of scenarios O and Q	0.0001101	0.21	5.3E-06	0.029	7.3E-07	0.0006672	1.7E-08	

1) Exposure concentration based on 0.5 hr of large area clearance and 3.5 hours of moving boxes

2) Exposure concentration based on 1 hr of large area clearance and 7 hours of moving boxes

Table D-9
Contractor with Cleavage Fragments Included (WA Study)

Residential		Exposure Concentration (fibers per cubic centimeter PCME) / Risk			
Activity	Scenario	Data	Time Weighting Factor	Worker (f/cc)	Risk
Ceiling Penetration	Typical	Ewing 2003	0.0000156	0.54	1.9E-06
Ceiling Penetration	High-end	Ewing 2003	0.0002752	0.54	3.4E-05
Moving Aside VAI - Grace Method	Typical	Ewing 2003	0.0000052	4.48	5.4E-06
Moving Aside VAI - Grace Method	High-end	Ewing 2003	0.0001101	4.48	1.1E-04
Moving Aside VAI - Homeowner Method	Typical	Ewing 2003	0.0000052	9.57	1.1E-05
Moving Aside VAI - Homeowner Method	High-end	Ewing 2003	0.0001101	9.57	2.4E-04
Shop Vac Removal VAI from top perimeter wall cavities	Typical	Ewing 2003	0.0000026	0.69	4.1E-07
Shop Vac Removal VAI from top perimeter wall cavities	High-end	Ewing 2003	0.0000826	0.69	1.3E-05

Table D-10
Resident Risk (Versar)

Activity	Scenario	Data	Time Weighting Factor	Exposure Concentration (fibers per cubic centimeter PCME) / Risk	
				Worker (f/cc)	Risk
Residential					
Using the attic with vermiculite insulation as a storage space	Typical	Versar 2002	0.0000147	0.13	4.3E-07
Using the attic with vermiculite insulation as a storage space	High-end	Versar 2002	0.0001957	0.25	1.1E-05
Wiring or small renovation in an attic containing dry vermiculite	Typical	Versar 2002	0.0000016	1.5	5.5E-07
Wiring or small renovation in an attic containing dry vermiculite	High-end	Versar 2002	0.0000122	2.6	7.4E-06
Removing vermiculite attic insulation	Typical	Versar 2002	0.0000130	0.31	9.2E-07
Removing vermiculite attic insulation	High-end	Versar 2002	0.0000196	0.40	1.8E-06

Table D-11
Contractor Risk (Versar)

Contractor				Exposure Concentration (fibers per cubic centimeter PCME) / Risk
Activity	Scenario	Data	Time Weighting Factor	Worker (f/cc) Risk
Wiring or small renovation in an attic containing dry vermiculite	Typical	Versar 2002	0.0000156	1.5 5.2E-06
Wiring or small renovation in an attic containing dry vermiculite	High-end	Versar 2002	0.0002752	1.5 9.3E-05
Removing vermiculite attic insulation	Typical	Versar 2002	0.0000416	0.31 2.9E-06
Removing vermiculite attic insulation	High-end	Versar 2002	0.0006605	0.31 4.6E-05

Table D-12
Summary of Exposure Concentrations

		<u>Exposure Concentrations (f/cc)</u>							
		<u>Worker</u>			<u>Helper</u>			<u>Bystander</u>	
		<u>typ</u>	<u>high end</u>	<u>typ</u>	<u>high end</u>	<u>typ</u>	<u>high end</u>	<u>typ</u>	<u>high end</u>
Lees									
Moving Boxes		0.00050	0.00300	0	0	0	0	0	0
Small Area Clearance		0.09850	0.20700	0.00725	0.02900	0	0	0	0
Small Area Clearance & Fan Installation		0	0	0	0	0	0	0	0
Large Area Clearance		0.01663	0.04125	0.00294	0.00375	0	0	0	0
WA State Study									
Cleaning Stored Items		0	0	0	0	0	0	0	0
Ceiling Penetration		0.04992	0.04992	0.11356	0.11356	0	0	0	0
Moving Aside VAI - Grace Method		0.52104	0.52104	0	0	0	0	0	0
Moving Aside VAI - Homeowner Method		0.56736	0.56736	0.09618	0.09618	0	0	0	0
Shop Vac Removal VAI from top perimeter wall cavities		0	0	0.07187	0.07187	0	0	0	0
With Cleavage Fragments									
Lees									
Moving Boxes		0.03828	0.13584	0	0	0	0	0.00076	0.00458
Small Area Clearance		0.58082	0.67672	0.03017	0.07113	0	0	0	0
Small Area Clearance & Fan Installation		0.22369	0.23635	0.00079	0.00158	0	0	0	0
Large Area Clearance		0.20993	0.36138	0.02870	0.04519	0.00067	0.00400	0	0
WA State Study									
Cleaning Stored Items		0	0	0	0	0	0	0	0
Ceiling Penetration		0.54256	0.54256	0.68396	0.68396	0	0	0	0
Moving Aside VAI - Grace Method		4.47703	4.47703	0.00000	0.00000	0	0	0	0
Moving Aside VAI - Homeowner Method		9.57461	9.57461	1.74885	1.74885	0	0	0	0
Shop Vac Removal VAI from top perimeter wall cavities		0.68688	0.68688	0.21562	0.21562	0	0	0	0
Versar									
Using the Attic with Vermiculite Insulation as a Storage Space		0.12725	0.24660	0	0	0	0	0	0
Wiring or Small Renovation in an Attic Containing Dry Vermiculite		1.46280	2.64760	0	0	0	0	0	0
Removing Vermiculite Attic Insulation		0.30565	0.40010	0	0	0	0	0	0

Table D-13
Lees et al Data (RJ Lee Analysis)

PCME Asbestiform	f/cc	PCME + cleavage fragments	f/cc
Test O	Worker B	Test O	Worker B
Test Q	Worker B	Test Q	Worker B
Test O	Worker A	Test O	Worker A
Test O	Worker A	Test Q	Worker A
Test O	Helper B	Test O	Helper B
Test Q	Helper B	Test Q	Helper B
Test O	Helper B	Test O	Helper B
Test Q	Helper A	Test O	Helper A
Test O	Helper A	Test Q	Helper A
Test O	Bystander B	Test O	Bystander B
Test Q	Bystander B	Test Q	Bystander B
Test O	Bystander A	Test O	Bystander A
Test Q	Bystander A	Test O	Bystander A
Test Q	Bystander A	Test Q	Bystander A
Test D	Worker B	Test S	Worker B
Test K	Worker B	Test K	Worker B
Test S	Worker B	Test D	Worker B
Test S	Worker A	Test K	Worker A
Test D	Worker A	Test S	Worker A
Test K	Worker A	Test D	Worker A
Test D	Helper B	Test D	Helper B
Test K	Helper B	Test K	Helper B
Test S	Helper B	Test S	Helper B
Test D	Helper A	Test D	Helper A
Test K	Helper A	Test K	Helper A
Test S	Helper A	Test S	Helper A
Test D	Bystander B	Test K	Bystander B
Test K	Bystander B	Test S	Bystander B
Test S	Bystander A	Test D	Bystander A
Test D	Bystander A	Test K	Bystander A
Test K	Bystander A	Test S	Bystander A
Test S	Bystander A	Test M	Worker B
Test F	Worker B	Test M	Worker B
Test M	Worker B	Test F	Worker B
Test F	Worker A	Test M	Worker A
Test M	Worker A	Test F	Worker A
Test M	Helper B	Test M	Helper B
Test F	Helper B	Test F	Helper B
Test M	Helper A	Test M	Helper A
Test F	Helper A	Test F	Helper A
Test M	Bystander B	Test M	Bystander B
Test F	Bystander B	Test M	Bystander B
Test M	Bystander A	Test F	Bystander A
Test F	Bystander A	Test M	Bystander A
Test H	Worker B	Test H	Worker B
Test H	Worker A	Test H	Worker A
Test H	Helper B	Test H	Helper B
Test H	Helper A	Test H	Helper A
Test H	Bystander B	Test H	Bystander B
Test H	Bystander A	Test H	Bystander A

PCME Asbestiform	f/c	
Test O	Worker B	0.209
Test Q	Worker B	0
Test O	Worker A	0.309
Test Q	Worker A	0
Test O	Helper B	0.030
Test Q	Helper B	0.023
Test O	Helper A	0.027
Test Q	Helper A	0.014
Test O	Bystander B	0
Test O	Bystander B	0
Test O	Bystander A	0
Test Q	Bystander A	0
Test D	Worker B	0
Test K	Worker B	0
Test S	Worker B	0
Test S	Worker A	0.003
Test D	Worker A	0
Test K	Worker A	0
Test D	Helper B	0
Test K	Helper B	0
Test S	Helper B	0
Test D	Helper A	0
Test K	Helper A	0
Test S	Helper A	0
Test D	Bystander B	0
Test K	Bystander B	0
Test S	Bystander B	0
Test D	Bystander A	0
Test K	Bystander A	0
Test S	Bystander A	0
Test D	Worker B	0.097
Test K	Worker B	0.090
Test S	Worker A	0.207
Test D	Worker A	0
Test K	Worker A	0
Test S	Worker A	0.029
Test F	Helper B	0
Test M	Helper B	0
Test F	Helper A	0
Test M	Helper A	0
Test F	Bystander B	0
Test M	Bystander B	0
Test F	Bystander A	0
Test M	Bystander A	0
Test F	Worker B	0
Test H	Worker B	0
Test H	Worker A	0
Test H	Helper B	0
Test H	Helper A	0
Test H	Bystander B	0
Test H	Bystander A	0

PCME Asbestiform (ff/cc)						
	worker	helper	bystander			
	max	avg	max	avg	max	
LAC	1.66E-02	4.13E-02	2.94E-03	3.75E-03	0.00E+00	0.00E+00
MB	5.00E-04	3.00E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SAC	9.85E-02	2.07E-01	7.25E-03	2.90E-02	0.00E+00	0.00E+00
SACF	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Test Q	1.30E-01	3.09E-01	2.35E-02	3.00E-02	0.00E+00	0.00E+00

PCME w Cleavage Fragments (ff/cc)						
	worker	helper	bystander			
	max	avg	max	avg	max	
LAC	2.10E-01	3.61E-01	2.87E-02	4.52E-02	6.67E-04	4.00E-03
MB	3.83E-02	1.36E-01	0.00E+00	0.00E+00	7.63E-04	4.58E-03
SAC	5.81E-01	6.77E-01	3.02E-02	7.11E-02	0.00E+00	0.00E+00
SACF	2.24E-01	2.36E-01	7.88E-04	1.58E-03	0.00E+00	0.00E+00
0	0	0	0	0	0	0
0	0	0	0	0	0	0
Test Q	1.41E+00	1.94E+00	2.30E-01	3.62E-01	0.00E+00	0.00E+00

Table D-14
PCM_E Concentrations Based on WA State Study (RJ Lee Analysis)

Description	Type	Total TWA	PCM Equivalent, f/cc	Asbestiform TWA
Zonolite Attic Insulation Removal - "WR Grace Method" - Spokane				
personal	worker	4.48	0.52	
personal	Assistant	0.00	0.00	
Ceiling Penetration - Spokane				
personal	Worker	0.54	0.05	
personal	Assistant	0.68	0.11	
Zonolite Attic Insulation Removal - Homeowner Method - Spokane				
personal	worker	9.57	0.57	
personal	Assistant	1.75	0.10	
Cleaning Study - Spokane				
personal	Assistant	0.00	0.00	
personal	Worker	0.00	0.00	
Zonolite Attic Insulation Removal - Shop Vacuum Removal - Spokane				
personal	worker	0.69	0.00	
personal	Assistant	0.22	0.07	

Table D-15
Versar Data Summary

Based on Studies Conducted in Simulation Systems		Exposure Conc. (structures/cc)^a		
Exposure Scenario		Minimum	Maximum	Mid-Range
Active Exposures				
Wiring or small renovation in an attic containing dry vermiculite		0.28	2.65	1.46
Removing vermiculite attic insulation		0.21	0.40	0.31
Using the attic with vermiculite insulation as a storage space		0.01	0.25	0.13

EXHIBIT F